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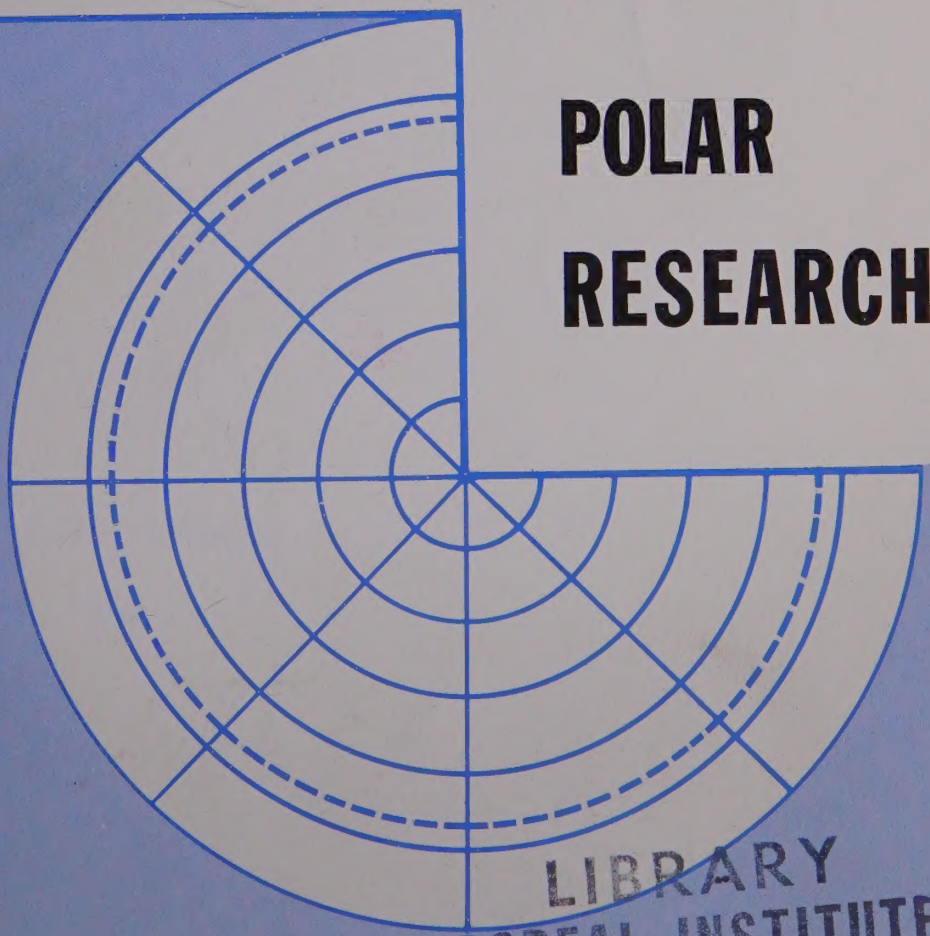
REPORT
OF THE
UNIVERSITY
COMMITTEE ON

POLAR RESEARCH



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Gift from Wm. R. Farrand, Head
Glacial Geology & Polar Research Laboratory,
Institute of Science & Technology,
University of Michigan. U.S.A.
See letter dated 14 March, 1967.

REPORT

of

THE UNIVERSITY COMMITTEE

ON POLAR RESEARCH

Ann Arbor, Michigan

March, 1961

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CONTENTS

Part I. The Polar Regions 5

Part II. The University Committee on Polar Research . . 8

Part III. Summary of Results of the Survey Conducted by Questionnaire 11

Geophysics of the Solid Earth: Maurice Ewing 12

Physics of the Upper Atmosphere: C. T. Elvey 13

Meteorology and Climatology: P. E. Church 15

Oceanography: C. A. Barnes 17

Geology: J. C. Craddock 20

Glaciology: R. P. Goldthwait 21

Soil Science: M. G. Morgan 24

Biological Sciences: W. S. Benninghoff 25

Health Sciences: I. M. Taylor 27

Anthropology-Archaeology: V. F. Ray 29

Part IV. Recommendations 33

Appendix 1. Polar Research Questionnaire 40

Appendix 2. Comments on Summary Report of the Dartmouth Conference 43

SUPPLEMENT. Detailed analyses of survey conducted by questionnaire. (Bound separately and available upon request from Dr. J. H. Zumberge, Department of Geology, The University of Michigan, Ann Arbor, Michigan.)

Part I

THE POLAR REGIONS

BOTH THE NORTH AND SOUTH POLAR environments are dominated by rigorous cold climates and characterized by months of daylight alternating with equal periods of continuous darkness. The two polar regions are also noted for their magnificent displays of the aurora borealis and aurora australis. But beyond these comparatively few similarities, the Arctic and Antarctic are strikingly different.

The North Pole is situated near the center of a deep oceanic basin surrounded by land areas which almost isolate the Arctic waters from other northern ocean areas except at the narrow Bering Strait between Alaska and Siberia, and the much wider expanse of sea between Greenland and Norway. The south polar region, on the other hand, is dominated by a mile-high continent surrounded by frigid seas of the earth's three great oceans, the Atlantic, Pacific, and Indian.

The bleak Antarctic continent is devoid of land animals save penguins and other birds which are basically dependent on marine animals for their sustenance. It is a vast waste, burdened by glacier ice which is pierced by isolated nunataks and fringed by narrow belts of moraine and rock outcrops. In contrast to this environment, the Arctic lands are not only carpeted with a green tundra or boreal forest, but also possess a great variety of animal life, including man himself. Indeed, early man used the Siberian-Alaskan land bridge more than ten thousand years ago as a stepping stone in his first migration to the New World. The extreme isolation of the Antarctic, and the lack of natural land food and fuel, prevented a comparable invasion of that region by any hardy, adventurous peoples from the South Seas in past ages.

Contrasts between the north and south polar areas are evident from the manner in which they are viewed by the great world

powers. On the one hand, the Soviet Union has joined with the United States and other nations of the free world in signing a treaty which declares the Antarctic a free and open territory for all who wish to use it for scientific study. No political boundaries are recognized, nor are national claims upheld. Antarctic research, although of little strategic value today, is of great importance to the solution of fundamental problems in the natural sciences. The course of Antarctic research is planned by civilian scientists, who direct their efforts toward discovery of new facts about this little known part of the earth. Military personnel serve as logisticians and transportation experts. The Arctic Ocean, however, is a true mediteranean sea, bounded by world powers which acknowledge openly the strategic aspects of this ocean. Research in the Arctic is viewed by governments to be of great strategic importance, and the research is not only influenced by military requirements, but even dictated, to a large extent, by military demands.

The land, sea, and atmosphere surrounding the north and south poles constitute research laboratories for a relatively small number of scientists in the United States, both civilian and military. The focus of attention on these two intriguing frontiers was recently sharpened when the aims and accomplishments of the International Geophysical Year of 1957–58 were announced to the world. Since then, strong interest in polar regions has persisted, and in fact, has been intensified, both through an increased number of people who have decided to make a career of polar studies in one of the fields of natural, physical, or social sciences, and through increased support for research.

Yet, in terms of the work that remains to be done, the number of capable scientists dedicated to research in polar regions is appallingly small. The task of producing a continuing supply of qualified people for polar investigations clearly belongs to the institutions of higher learning. It is primarily in the colleges and universities that ideas of new lines of investigation are generated and basic research is performed, rather than in government bureaus and contracting laboratories under pressure of practical requirements of a military or commercial nature.

To carry out investigations at the "ends of the earth," polar

scholars need the help of vigorous young scientists who will accept the challenge of polar climates and take delight in learning more of this most formidable of the environments of the earth. If those of us who are interested in polar research expect to attract a fair share of the new generation of scientists, we must not only demonstrate by our own activities that research opportunities do exist in polar areas; we must also provide the means for aspiring polar scientists to gain experience by taking part in polar investigations.

Part II

THE UNIVERSITY COMMITTEE ON POLAR RESEARCH

IN RECOGNITION OF THE IMPORTANCE of institutions of higher learning in polar research, Dr. Laurence M. Gould, President of Carleton College, and chairman of the Committee on Polar Research of the National Academy of Sciences, appointed a nine-man committee to investigate the way in which American colleges and universities could most effectively engage in polar research. The membership was later increased by five members to provide for more complete coverage of fields of interest.

The University Committee on Polar Research, hereafter referred to as the Committee, met for the first time in Washington, D.C., on May 5, 1959, with Dr. Gould. Shortly thereafter, Dr. Detlev Bronk, President of the National Academy of Sciences, appointed Dr. J. H. Zumberge of The University of Michigan as chairman of the Committee on the recommendation of Dr. Gould. The full membership of the Committee is as follows:

*C. A. Barnes, Department of Oceanography, University of Washington

*W. S. Benninghoff, Department of Botany, The University of Michigan

P. E. Church, Executive Officer, Department of Meteorology and Climatology, University of Washington

*J. C. Craddock, Department of Geology, University of Minnesota

C. T. Elvey, Director, Geophysical Institute, University of Alaska

Maurice Ewing, Director, Lamont Geological Observatory, Columbia University

R. P. Goldthwait, Department of Geology, Ohio State University

M. G. Morgan, Director of Research, Thayer School of Engineering, Dartmouth College

*V. F. Ray, Department of Anthropology, University of Washington

Roger Revelle, Director, Scripps Institute of Oceanography, University of California

Athelstan Spilhaus, Dean, Institute of Technology, University of Minnesota

*I. M. Taylor, M.D., Medical School, University of North Carolina

G. P. Woollard, Department of Geology, University of Wisconsin

J. H. Zumberge, Department of Geology, The University of Michigan, Chairman

(*Members added to the original group.)

The Committee, through its chairman, submitted a proposal to the National Science Foundation for operating funds necessary to support the activities of the Committee for one year. The chairman also appointed additional members to the Committee to attain wide coverage of scientific interests in polar research. At its second meeting on September 20–22, 1959, at Shenandoah National Park, the Committee decided to gather information by sending questionnaires to colleges and universities in the United States known to have interest in polar studies. The Committee adopted this expediency because it did not have sufficient funds for a personal canvass. Information was requested from 91 institutions. Letters from the Committee to 81 college and university presidents (exclusive of the respective institutions of the Committee members) served as a basis for procuring a list of questionnaire recipients. The distribution of questionnaires in the institutions of the Committee members was delegated to each member. Each college or university president was asked to submit a list of people from his institution who could respond to a questionnaire in any or all of the ten categories surveyed. A sample questionnaire is reproduced as Appendix 1 in this

report. Ten different subject-area categories were surveyed with respect to polar research:

1. Geophysics of the solid earth
2. Physics of the upper atmosphere
3. Meteorology and climatology
4. Oceanography
5. Geology
6. Glaciology
7. Soil Science
8. Biological Sciences
9. Health Sciences
10. Anthropology-Archaeology

The Committee met in Ann Arbor on March 21–22, 1960, to review the analyses of the questionnaire data. Preliminary recommendations were formulated during the concluding sessions of this meeting. The Committee was convened a fourth time, October 17–19, 1960, in Ann Arbor, to prepare abstracts of the survey results by fields, to formulate final recommendations, and to complete the manuscript for this report.

Part III

SUMMARY OF RESULTS OF THE SURVEY CONDUCTED BY QUESTIONNAIRE

THE MANPOWER, ACTIVITIES, AND FACILITIES, actual and potential, for polar research at academic institutions of the United States would best be surveyed by visiting delegations of polar scientists competent in appropriate research fields. Sufficient funds for such a survey were not available to the Committee, so it was necessary to adopt the expedient method of a questionnaire survey by mail (see sample copy of questionnaire form in Appendix 1 of this report).

Questionnaires returned from university and college departments were sorted out into ten research fields, and sent to the appropriate Sub-Chairmen (Committee members) for those fields. Information on the questionnaire forms was tallied, and a detailed report was prepared by each Sub-Chairman for his field. The complete analyses are too long and detailed to be included in this final report of the Committee, so these have been placed together in a separately bound supplement, available on request from J. H. Zumberge (Department of Geology, The University of Michigan, Ann Arbor).

There was considerable overlap in reporting from similar research fields within a few institutions; in some instances it was possible to correct the tallies from these reports, but in others it was not. Oversights, and a few errors, in reporting were discovered and corrected by Sub-Chairmen who were familiar with work at the institutions concerned. Some departments known to be engaged in polar research did not return questionnaires, and could not be counted. In general, however, the Committee believes that this survey constitutes a reliable cross section of current work, problems, and potentialities in polar research at the colleges and universities of the United States.

Geophysics of the Solid Earth

Maurice Ewing
Director, Lamont Geological Observatory
Columbia University

Twenty-six universities reported that 31 professional members are now active in polar research and 56 others are qualified for and interested in such work. A total of 27 graduate students in 9 departments have done or are now doing polar research. Most of this activity has taken place at Columbia University and the University of Wisconsin.

Only the University of Wisconsin offers a course dealing primarily with polar problems; the average enrollment is 12 graduate and 3 undergraduate students. No department contemplates adding a polar course in the future. Five departments report graduate theses related to polar areas completed within the past 5 years. Seven departments have such theses currently underway.

Only 25% of the departments reporting have special equipment for polar research, generally in the form of *portable* geophysical equipment. Four universities maintain separate polar libraries. However, about 50% have very limited polar library facilities or none at all. Columbia University and the University of Wisconsin have special collections of geophysical data from Arctic and Antarctic areas.

Five departments reported polar research projects in progress as of January, 1960. Since 1955, polar projects have been completed in 4 universities, and such projects are being planned to begin by 1962 in 3 universities.

The main deficiency seems to be the lack of opportunity to engage in polar research. Participation in polar work by the professional staffs of the reporting universities could be increased by nearly 200% (from 31 to 87) if additional opportunities were available. Secondly 50% of the reporting institutions have only poor polar library resources or none at all. Finally, one specific deficiency in logistics were reported: the lack of spot landings by aircraft on the ice for the purpose of obtaining geophysical data.

Activity and Facilities in Polar Geophysics of the Solid Earth in the Majority of the Reporting Universities
(In Order of Activity)

	Research					Facilities		
	Professional Research			Grad. Work				
	Complete	Current	Planned	Complete	Current	Libraries	Spec. Equipment	Spec. Collection
Columbia University	x	x	x	x	x	x	x	x
University of Wisconsin	x	x	x		x	x	x	x
University of Michigan	x			x	x	x	x	
University of Alaska		x	x			x		
University of Colorado				x	x			
University of Wyoming				x	x			
California Institute of Technology		x			x		x	
Massachusetts Institute of Technology		x					x	
Boston University	x			x	x			
Ohio State University							x	

Physics of the Upper Atmosphere

C. T. Elvey
Director, Geophysical Institute
University of Alaska

A summary of the survey pertaining to physics of the polar upper atmosphere deviates from those of other disciplines since research problems center about the magnetic rather than the geographic poles. Also, since probing and observing techniques employed in the investigations are effective at great distances, it is not always necessary to have the station in the polar region.

Eighteen universities report a total of 75 professional-level personnel working on problems of the upper atmosphere, of which 27% are at the University of Alaska. The balance are in the temperate latitudes and only a minor number have experience with the polar upper atmosphere. In addition, there are 86 professionals who could engage in upper atmosphere research. There are reported to be 1.1 graduate students for each professional person.

A large part of the research equipment listed by the universities is applicable to polar ionospheric research, either if moved to locations near the auroral zone, or even, in many cases, if directed toward auroral zone research from their present location.

Dartmouth College has a field station at Schefferville (Knob Lake), Quebec, Canada, located very near the auroral zone. The Geophysical Institute of the University of Alaska, just south of the center of the auroral zone, devotes most of the facility to research in physics of the upper atmosphere. It maintains special equipment at several field sites near College and throughout Alaska. The University of Illinois has a satellite monitoring site at Baker Lake, NWT, Canada.

Among the collections of data is a set of radiometersonde data at the University of Wisconsin for polar regions. Records of VLF (very low frequency) electromagnetic emission data, along with auroral, ionospheric radio wave absorption and magnetic data are located at Dartmouth College. The University of Alaska operates the IGY World Data Center for instrumental observations of aurora. Also at the University are a collection of ionograms, records of radio wave absorption, and other data of auroral zone phenomena, such as earth currents, magnetic variations, VLF electromagnetic records, and data on the scintillation of the radio stars.

A curriculum for studies of physics of the upper atmosphere in polar regions does not, in general, exist, but is merely part of a general curriculum which treats all geographical regions of the upper atmosphere. Some universities emphasize certain polar aspects such as the aurora and the auroral zone ionosphere. The University of Alaska awards a Ph.D. degree for research in auroral zone phenomena.

Among the reports of research activities in physics of the upper

atmosphere in polar regions, one finds a large variety of techniques used, such as probing by radio waves, studies of scintillations of radio stars and of signals from satellites, optical and radar studies of aurora, studies of electromagnetic emission from lightening discharges and aurora, studies of cosmic rays, probing with rockets and satellites, and studies of earth currents and geomagnetism from which interpretations may be made of the electric currents in the upper atmosphere.

Deficiencies in polar research on the upper atmosphere show a need for such data as the composition, pressure, winds, and temperatures over the polar regions; additional data on aurora within the polar cap; studies of all auroral zone phenomena at ends of magnetic field lines; investigations of solar-influenced phenomena throughout a sunspot cycle; further studies of radio wave absorption in the ionosphere; the emission of electromagnetic radiation and of sound waves from auroras; sizes and motions of irregularities in the ionosphere; electron density and collision frequencies throughout the atmosphere above 30 km; and the exact mechanism by which charged particles from the sun penetrate the atmosphere in the polar areas from, or via, the Van Allen radiation belts.

Meteorology and Climatology

P. E. Church
Executive Officer, Department of Meteorology and Climatology
University of Washington

About fifteen universities have full curricula in meteorology and climatology leading to the Ph.D., and are active in research, and about the same number of schools offer less training not leading to advanced degrees. Of this number, only two universities (University of Washington, University of Wisconsin) could be singled out as devoting much time and energy to polar problems. Both of these schools have projects dealing with the Arctic; no schools are doing any research in meteorology in the Antarctic. Several other schools have indicated they would be willing to embark on some phases of high-latitude meteorology where they felt they were capable.

Fewer than 200 professional people are both teaching and performing research in colleges and universities in this field, and less than 10% of these are presently active in polar research. About another 10% could and would participate if there were attractive opportunities. The total number of graduate students specializing in polar aspects and now working toward higher degrees is only 16, an appallingly small number.

Research facilities and special equipment designed specifically for polar problems are possessed by only two schools (University of Washington, University of Wisconsin), although many schools have equipment and facilities of various types which can be used at any latitude. None of the schools has separate polar libraries, although several, through their departmental libraries, attempt to keep most of the classical and current polar books and journals. If possession of raw and reduced data of various sorts constitutes a "special collection," then only two schools have such.

If courses and seminars on the physical geography of polar regions are disregarded, then only two schools (University of Washington, University of Wisconsin) offer seminars on polar meteorology or climatology and these seminars are offered on demand or occasion only.

Polar research activities resulting in student theses during the past five years have resulted in about 15 masters' and one Ph.D. Present work by graduates will result in 7 or 8 masters' and 3 Ph.D. theses when these graduates complete their work. The number of graduate students who had experience in polar field work is only 15.

Only one school (University of Washington) reported a substantial amount of research predating the International Geophysical Year; one other university (University of Michigan) completed a short-term project to help the Weather Bureau prepare for IGY Antarctic work. In polar meteorology in the future, the two active schools plan to continue and expand their research, and the other school (University of Michigan) envisages starting some work.

Basic to many of the unsolved problems in both meteorology and climatology is a network of observing stations, of the Weather Bureau type, for both surface and upper-air observations. The stations for upper air should be not more than 300 to 400 miles

apart and less than that for surface observations. The general circulation, production, and transformation of air masses, characteristics of fog, low stratus and surface inversions and all phases of climatology depend on network observations. Since the inauguration of IGY there has been a fair, though sparse, network on Antarctica; this has contributed greatly to our knowledge there. On the other hand, data from the Arctic Ocean are almost nil. During most of IGY there were only two U. S. observing stations for the Arctic Ocean, Alpha and Bravo, the former lasting but eighteen months. Station Charley was set up in 1959 (to replace Alpha) but was evacuated after eight months of operation. Station Bravo has been a rather ineffective station in many ways because for the past two years it has been close to the Canadian and Alaskan coasts.

At all future stations, careful monitoring and sampling of the atmosphere should be done for ozone, carbon dioxide, and other chemical constituents as well as radioactivity concentration. In micrometeorology, work on all phases of the heat budget should be more vigorously prosecuted and done so at no less than three different latitudes in each polar region. The general and detailed albedo of the surface during the light period should be observed routinely by properly instrumented small aircraft. In this short list of work to be pursued is the problem of forecasting accurately the drift of the Arctic Sea Ice.

Oceanography

C. A. Barnes
Department of Oceanography
University of Washington

The replies from the questionnaires in oceanography are confused by overlap of certain aspects of meteorology, geology, geophysics, fisheries and limnology with oceanography. Fifteen of the educational institutions reporting show some interest and capability in oceanography or in closely related fields involving marine sciences. None of the institutions is now offering or contemplating giving,

specific courses in polar oceanography. Three, the A. and M. College of Texas, Florida State University, and the University of Washington, treat the oceanography of high altitudes along with other areas in the general courses, and discuss special problems in seminars.

A total of thirty-five staff members at the professional level has had some experience in polar research involving problems in oceanography or bordering fields. Of this number twelve are from the University of Washington and ten from Columbia University. Only a few are now actively engaged in polar oceanography. Not a single university faculty member is spending more than a minor part of his time in such study. On the other hand, about seventy of the professional staff members, given suitable opportunity, could participate in certain phases of this work. The reporting departments list a total of about 450 graduate students, of whom 21, now working toward advanced degrees, have had previous experience in polar research. Not more than six graduate students are currently working on thesis problems which could involve any considerable amount of polar oceanography, and not more than two thesis problems in this field have been completed during the past five years.

Only three of the institutions list current research projects involving polar oceanography, and there is no indication of any immediate expansion of research effort, nor of long-range programs in this field. Practically all current research is being supported either directly or indirectly by the Federal Government.

The meager research effort in polar work is in sharp contrast to the considerable and rapidly increasing effort in the general field of oceanography. As a consequence, studies in polar oceanography are rapidly losing ground in relation to studies in other geographic areas. As all major educational institutions offering an integrated program covering all phases of this scientific field are now loaded to near capacity with students, any major expansion in polar work will require special effort on the part of the individual institutions. Increased support for this work on a broad basis from outside the institution will also be required since most of the institutions are not in a position to support any extensive amount of polar research on their own resources. Further, institutions which do not cover all phases of oceanography are limited in their ability to handle

adequately many of the complex problems in the polar seas which require coordinated effort from a number of the contributing branches of oceanography.

Twelve institutions have a limited amount of conventional equipment available for use in polar waters. Specialized equipment is almost nonexistent. Only three reporting universities equipped for broad studies in oceanography (the A. and M. College of Texas, Columbia University, and the University of Washington) have ships that can operate to the fringe of the ice areas, and none of the available ships is suitable for operating within the polar ice packs. Most polar oceanography done by university scientists has been carried out from Navy or Coast Guard vessels, but some work has been done from drifting ice stations established by the military, and by landings on the ice for brief periods during which spot observations were made. Planes and submarines have desirable freedom of movement and range which make them particularly useful in operating in pack ice areas, but have not been available to university scientists.

All institutions have a nucleus of common publications relating to polar research in their general libraries. In addition, two institutions have separate polar libraries, and three have departmental libraries which maintain a good working collection of polar publications. Regarding other reference material, very limited collections of bottom, biological, and water samples are available.

Lack of suitable logistic support, paucity of facilities, inadequate funding on a continuing basis and low recruitment of scientific personnel were named as contributing to the present deficiency in research effort.

Considering specific research problems, the following are among those requiring attention:

(1) Areas and mechanism of formation and the dynamics of polar water masses including the bottom waters of both the Arctic and Antarctic as well as of the peripheral waters such as Baffin Bay.

(2) Water, salt, and heat budgets of the Arctic Ocean.

(3) Dynamics of the circulation between Bering Sea and the adjacent Arctic, and between the Atlantic and the Arctic.

(4) The oceanographic polar fronts including observations of

water properties and life in the sea as well as meteorological conditions.

(5) Air-sea inter-relationships and sea-ice limits over broad geographic areas in the polar regions. In this regard, the information now at hand is not sufficient to permit a rigorous analysis of the drift of ice as influenced by wind.

(6) The annual regime of food-chain relationships in the near-surface waters of ice covered areas. The nature, populations, and contributions of the individual organisms offer many distinct problems transcending the general relationships.

(7) Nature of bottom deposits and history of sedimentation in the Arctic basin. Special attention should be given to ice as a transporting agent and also as an agent which modifies the distribution of bottom materials along the shoreline, on the continental shelves, and on shallower parts of the continental slopes.

Many of the problems posed require for their solution continued sequences of field observations in and bordering ice-covered areas, sequences which extend throughout the year. Coverage in the past has been too spotty in both time and place and too restricted in scope to put the oceanography of the polar regions on the quantitative basis required for a real understanding of the regions.

Geology

J. C. Craddock
Department of Geology
University of Minnesota

Thirty-eight institutions report 62 professional scientists who have been or are presently active in polar work. Of the 1372 geology graduate students in these institutions, only 48 have done or are doing polar geologic work.

Two institutions presently offer courses (two at Purdue University, one at Missouri School of Mines) mainly concerned with some aspect of polar geology. Four other institutions are considering establishing such courses in the future, generally as graduate sem-

inars. In most institutions a part of the course in geomorphology is devoted to cold-weather geologic processes.

Specialized equipment, aside from trail gear, is not needed for polar geologic field work. The reporting institutions are mainly well equipped with the standard geology department laboratory and field equipment. In addition, three (University of Michigan, Ohio State University, Purdue University) report cold-room facilities. Only three institutions (Dartmouth College, Iowa State University, University of Michigan) maintain special polar libraries; most have on hand only the collections of the general or departmental library or less. Thirteen institutions report collections of rocks or fossils from polar areas.

Sixteen institutions completed projects in polar geology during the last five years; 18 graduate theses, including 11 doctoral dissertations, resulted from this work in addition to other reports and publications. Eighteen different sources of support were reported, but only graduate schools, IGY, and SIPRE were mentioned more than once.

Only five institutions reported polar geologic research projects in progress on January 1, 1960. Two groups were operating with local funds, one with foreign support, and two mainly through NSF grants. Seven institutions plan to begin new projects within the next two years, and four others are contemplating new programs but have no definite plans as yet.

Glaciology

R. P. Goldthwait
Department of Geology
Ohio State University

Twenty-one universities and colleges indicated some activity in the field of glaciology.* Much of this is true study of glaciers although a few universities are probably more concerned with the glacial

* Two added since the original questionnaire (University of Alaska and University of Miami).

geology of deposits. Glaciology is a stepchild involving seismology, climatology, hydrology, photogrammetry, stratigraphy, and structure, so it is no wonder that we find it incorporated in 14 geology departments, 3 departments of geology and/or geophysics, 2 combinations with geography, 2 engineering departments, and 1 meteorology department.

Forty professional academic men claim to do glaciological research in the United States, but in only two new cases (University of Alaska and University of Miami) is this the man's sole field of research. Nine of the most active are geomorphologists. Because much research is with glacial deposits (including ocean floor sediments, etc.), it is an exaggeration to say that the 21 institutions active in glaciology average two staff men in glaciological research. The graduate students now engaged in this discipline are not even as numerous as the faculty (27). They make up about 5% of all earth-science graduate students at these institutions and less than 1% of all graduate students in the United States.

Glaciology is listed as a major part of some one course given at each of six colleges and universities. Only one (California Institute of Technology) actually lists "glaciology," but four others plan such courses. Obviously, present training is mostly in the related background subjects; no schools grant degrees in glaciology.

Special facilities for glaciology are extremely limited. Most commonly (7 cases) there is access to cold rooms, although only two cold rooms are devoted chiefly to glaciological research. More than half the responses indicate no special glaciological instruments for teaching or research and the others have a scattering of Rigsly stages, ice coring augers, special photogrammetric equipment, etc. Two have special polar libraries (Dartmouth College and University of Michigan), and nearly half the host departments have significant libraries of polar books. Only one (University of Michigan) stores ice specimens yet. Volumes of original IGY-IGC data are kept at one (Ohio State University), but the only large glacier photo-map collection is not at a university, though one is in progress at the University of Washington.

Past research degrees based upon glaciological work number 11 masters' and 8 doctorates in 5 years and concentrated at just 6

universities. Ohio State University leads with 5, but as in all past cases, these involve just Arctic areas. The Antarctic came into its own with IGY-IGC inclusion of a glaciology program so that about half of the 14 advanced degrees now in progress are in Antarctic research. Faculty research at present involves 17 projects at 10 universities.

It is obvious that there are virtually no experienced senior academic men devoted chiefly to glaciology and there are few graduate students entering this field. Yet the call for such men is regular and represents a real need. A few full-time glaciologists are found in government laboratories, but generally permanent jobs in this field have not been created. No American university is fully

TABLE OF ACADEMIC ACTIVITIES IN GLACIOLOGY

	People		*Dept.*	*Course*	*Facilities*	
	No. of Staff Men Involv.	No. Grad. Students	Home of Glaciol.	Some Glac. Included	Cold Room	Special Instruments
*Univ. of Alaska	2	1 in 3+	geology	(x)		
Cal. Inst. of Tech.	3	1 in 58	geology	x		x
Univ. of Colorado	1	1 in 50	geology	x		
Columbia Univ.	6	1 in 20	geophys.			
Dartmouth College	1?	0	geology		x?	
Univ. of Denver	2	1 in 3	geogr.	x		
Florida St. Univ.	2	0	geology			
Univ. of Maine	1	0	geol.-geog.	x		
*Univ. of Miami	1	0	engineer.			
Univ. of Michigan	6	8 in 65	geology		x	x
Univ. of Minnesota	0	1 in 50	geology	x	x	
Univ. of Missouri	1	0	geology			
Northwestern Univ.	1	0	geology		x	
Ohio State Univ.	1	2 in 45	geology	x	(x)	x
Purdue Univ.	4	2 in 15	engineer.			
South Dakota Univ.	1	0	geology			
Stanford University	3	2 in 60	geophys.			
Washington Univ.	2	3 in 25	geology			
Univ. of Washington	3	1 in 40	meteorol.		x	x
Univ. of Wisconsin	1	2 in 75	geol.-geoph.			
Univ. of Wyoming	0	1 in 27	geology			

* Additions since original questionnaire.
+ Total number of graduate students in department.

equipped for glaciological teaching or research. There is no North American field station for regular training in glaciology.

Research in the United States is inadequate to attack any of the pressing glaciological problems which are being solved increasingly in Sweden, Great Britain, Norway, Denmark, France, and Austria. This may be attributed to the dearth of experienced senior glaciologists, to the irregular year-by-year financial support of glaciological research without permanent laboratories or stations, and to dependence on military logistics which often have been exasperating because they are not oriented toward scientific accomplishment.

Soil Science

M. G. Morgan
Director of Research
Thayer School of Engineering
Dartmouth College

Eight universities reported current research in this field; two of them (University of Alaska and Stanford University) offer one course of instruction each, as does one other (Ohio State University). Of 25 universities, a total of 36 professional-level departmental members currently or previously active in polar research, and 109 others as potentially available, were reported. Only 18 current graduate students have been or are engaged in polar research in soil science.

Twelve universities reported cold-room facilities ranging in scope from very moderate and general, to extensive and special. One maintains a comprehensive polar library (Dartmouth College) and two have small departmental polar libraries (University of Washington and Stanford University).

Five Ph.D.'s have been produced since 1955 and 6 are in progress.

Attention in this field ranges from soil generation and loss, physical properties and mechanics, to biological support. With less than 2% working in this field, of the more than 900 graduate

students currently engaged in polar research, it is evident that it should have greater emphasis, especially with greater attention to biological aspects, and to the Antarctic where investigation is almost totally lacking.

Biological Sciences

W. S. Benninghoff
Department of Botany
The University of Michigan

Questionnaires were sent to 88 departments in 56 universities and colleges; replies were received from 54 departments in 41 institutions. About 10 institutions have both research programs and some teaching relating to polar biology. The University of Alaska is outstanding; it has the largest number of research projects, and is the only institution that now offers formal courses (10 in all) which are primarily oriented toward polar biology. Other leading institutions are: University of Colorado, Duke University, University of Illinois, University of Michigan, Michigan State University, Stanford University, and Washington University in St. Louis. Polar research in only one or two specialties is in progress at some institutions, e.g., Iowa State University, Kansas State University, and University of Massachusetts. Twenty-five institutions reported research activity for a total of 51 clearly defined projects; eight reported only one project each, and sixteen indicated that further projects are contemplated. Seventeen institutions reported no research in progress; nine of these indicate no past record of research activity, and only one of the nine expects to initiate a project in the near future.

Thirty-one institutions have 75 professional scientists now or formerly engaged in polar research, almost one-half of whom are at the following six universities: Alaska, Illinois, Massachusetts, Michigan, Michigan State, and Stanford. The total number of professional scientists who could participate (including those now engaged) in polar research amounted to 244 at 39 institutions, the larger numbers coming from the University of Chicago, University of Kansas, University of Maryland, Massachusetts Institute of Tech-

nology, University of Michigan, Michigan State University, and University of Minnesota. Eighteen institutions have a total of 49 graduate students who are now or have been active in some form of polar research. Thus, of the total of 2020 graduate students in the reporting departments, only 2.4% have had some participation in polar research, and these are at fewer than one-half of the institutions. In general, professional-level members with polar research experience are strongly clustered in relatively few institutions, but this is not proportional to the sizes of the institutions (e.g., University of Alaska: 10, University of Massachusetts: 4). Only about one-third of those qualified have engaged in polar research, and many of these only briefly. The number of graduate student theses related to polar research appears to be increasing, with Ph.D. thesis production increasing the faster.

The University of Alaska is the only institution that now offers courses (10 in all) that are primarily oriented toward polar biology. Two institutions (Duke University, University of Missouri) have courses with significant proportions of material on polar biology. Three institutions (University of Alaska, Stanford University, and Syracuse University) have plans for new courses in which polar biology will be emphasized.

Cold-chamber facilities suitable for culture of organisms and experimentation are possessed by fourteen institutions, and simpler cold-room facilities are held by seven others. Ten institutions have important zoological collections, and five have important specialized collections of marine organisms. Eighteen institutions have significant herbarium collections, four have collections of fossil plants, four have living arctic and alpine plants, and four have collections of pollen and spores. Only the University of Alaska and Dartmouth College have separate polar libraries, although neither one emphasizes biological sciences literature. Eight universities have biological science (departmental) libraries in which efforts are made to maintain polar research literature. Institutions strong in polar biological research are not maintaining separate polar libraries. Only 5 of 41 institutions considered their holdings of polar literature very limited.

Twenty-four institutions report 51 projects in progress, of which 20 are in zoology (birds, regional marine faunas, wildlife,

physiology, etc.), 12 in botany (regional vascular plant floras, mycology, physiology, etc.), and 19 in ecology (plant ecology, limnology, etc.). Only 15 new research projects were listed as proposed for initiation in 1962, and 11 of these were at the University of Alaska. Reporting on completed projects was too fragmentary for evaluation.

Cold-environment chambers are being used relatively little in polar research problems. There is a general lack of investigations under winter conditions. In spite of considerable diversity of research activity, there is lack of attention to terrestrial invertebrates, animal genetics and evolutionary processes, systematics, and distribution of lower animals (e.g., rotifers, nematodes), lichens, plant genetics and evolutionary processes, soil microbiology, and ecosystem studies. Although undoubtedly being considered within many of these existing projects, biogeography and evolutionary aspects of adaptation do not appear to be given the emphasis that seems appropriate to opportunities offered by the polar environments and necessary for a balanced program of polar biological research.

Health Sciences

I. M. Taylor, M.D.
Medical School
University of North Carolina

All schools teaching and doing research in the Health Sciences are contributing to the potential in the field of polar studies because of the general applicability of the substances of the health sciences.

Our survey indicates that about 100 professionally qualified persons are potentially available for research in the health sciences as related to polar problems. This very low figure represents only a small fraction of the current manpower potential in this area. The field of health sciences is so broad that many biological disciplines are embraced, and it is fair to say that all researchers in the biological sciences *could* contribute to polar aspects of health sciences.

Little formal course work is available in polar aspects of the health sciences. It should be pointed out, however, that biology in

general, public health, dentistry, and medical studies all presently provide excellent training which may be applied to the health sciences in polar research. Although a few departments seem to encourage graduate students to do thesis work in polar problems, the over-all number of graduate students doing so is small. Where such graduate work is in progress, it seems clearly the result of special interest on the part of senior members of the department.

The only present or contemplated course reported to the Committee was one at the State University of Iowa on environmental physiology in which about a dozen graduate students are enrolled yearly. In the past 5 years, 4 masters' and 5 doctoral theses were reported as having been completed. Five candidates for the Ph.D. are currently doing thesis work on problems related to polar research.

Facilities appear adequate for the needs of those now doing research or wishing to do research in health sciences. Library facilities seem, however, to be marginal in most institutions.

Considerable research is now underway in the health science field on problems related to polar research. As in teaching, the work being done in various departments appears to reflect the interest of individual investigators. There is no evidence of serious lack of financial or logistic support. Most of the work is in environmental physiology and Arctic biology and is supported by the medical research funds of the United States Public Health Service and the Department of Defense.

Participation of university scientists in health science research related to polar problems should be broadened by the establishment of suitable research facilities in polar areas. Investigators should be offered the opportunity to pursue for extended periods problems of interest to them in well-equipped laboratories in the Arctic and the Antarctic. Provision of living quarters for families would be desirable.

Research is needed on the following problems, among others:

1. Adaptation of tissue to polar environment on long-term (evolutionary) basis.
2. Studies of the survival and infectivity of pathogenic microbiological agents in polar regions.

3. Winter biology in polar areas.
4. Field studies on cold acclimatization.
5. Effects of polar light cycles on animal activity.
6. Effects of polar light cycles on human physiology and psychology.
7. Studies of sanitation and public health in Arctic and sub-Arctic areas.

Development of medical logistics in support of research in the polar areas is also needed.

Anthropology-Archaeology

V. F. Ray
Department of Anthropology
University of Washington

All polar research in anthropology-archaeology is Arctic since no group of mankind has ever made a home in the Antarctic.

Polar research and training in anthropology fall generally into three special fields: archaeology, physical anthropology, and ethnology. Most current research and that of recent years is either archaeological or ethnological. The questionnaire responses have been analyzed in terms of these subdivisions.

The questionnaire was sent to 27 institutions, of which all responded. Eighteen responses were wholly or substantially negative. Six institutions reported ongoing research and training programs: University of Alaska, Brown University, Cornell University, University of Pennsylvania, University of Washington, and University of Wisconsin. Three others—University of Minnesota, University of North Carolina and University of Oklahoma—reported one faculty member each with an individual program of polar research, but no cooperative activity or student training in formal courses. Faculty research and undergraduate training is carried on at Dartmouth College.

Because only six universities reported research and training programs in anthropology-archaeology, evaluations below are made, for the most part, in specific numbers rather than percentages.

Only 16 experienced professional persons are now, or have recently been, active in Arctic research. These are about equally divided between archaeology and ethnology. It is reported that 39 persons are competent to participate in polar research but it is uncertain whether this means 39 additional or 39 including the 16 reported as now active.

The number of graduate students with polar research experience is only eight, five of whom are at the University of Washington. This is but 4% of the total graduate students in anthropology-archaeology at the institutions concerned—over 200.

Courses specifically on the Arctic are few, totaling only twelve. Only two universities offer more than one course. The University of Alaska schedules four, with three of these given only every second year; the University of Washington offers three courses each year. The University of Alaska, Cornell University, and University of Washington are contemplating the expansion of their offerings. Most courses, actual and proposed, are designed for both graduate students and undergraduates.

Theses, likewise, have been few. Four are currently underway; six degrees were granted during the past five years. Of the total, eight are Ph.D.'s.

The previous polar research experience of graduate students was not fully reported but most support appears to have been private. The Air Force and the Alaska Native Service are the only other sources mentioned.

Anthropologists do not require much special equipment for Arctic research. The principal needs are well-equipped laboratories at the home base, and these are relatively numerous. At least a dozen of the responding institutions have good laboratory facilities for archaeology, and some for physical anthropology.

Six large artifact collections are located in the universities, plus nine smaller collections. Several of the universities have large museums associated with them, notably Harvard University, University of Pennsylvania, and University of Washington, in which Arctic collections are prominent. Brown University has valuable artifacts and faunal remains covering 8000 years of human occupation of the Bering Strait region.

The University of Alaska and Dartmouth College maintain separate Arctic libraries. Harvard University and the University of Pennsylvania have departmental Arctic libraries. In other universities the polar library materials are located in the main libraries.

Completed activities are: Denali archaeological survey (University of Alaska); Archaeology of Choris Peninsula, Kotzebue Sound, and Beachridge archaeology, Cape Prince of Wales and Kotzebue Sound (Brown University); Eskimo socio-cultural change, St. Lawrence Island (Cornell University); Human ecology, Point Barrow and vicinity (University of Minnesota); Great Whale River Eskimo study (University of North Carolina); Barter Island study (University of Oklahoma); Archaeology of the American Arctic (University of Pennsylvania); Archaeological and ethnological studies in Alaska and vicinity (University of Washington).

In progress are: Project "Chariot" (University of Alaska); Beachridge archaeology (Brown University); Archaeology of Bering Strait region (University of Pennsylvania); Eskimo perception patterns, Eskimo kinship systems, ethnic study of Labrador (University of Washington).

Proposed investigations are: Archaeological survey of national parks in Alaska (University of Alaska); Continuation of archaeological research; western Alaska (Brown University); Anthropo-physiological study (University of Minnesota); Contemporary Eskimo resettlement (University of North Carolina); Continuation of Arctic archaeological research (University of Pennsylvania); Continuation of Eskimo kinship study, and ethnic study of Labrador (University of Washington).

Some significant—even critical—areas for archaeological research have not been touched. In the social and cultural fields, many years of extensive and intensive study by scientifically trained field workers will be required before we can pretend to have an adequate knowledge of the human adaptations which have been made to life in the Arctic, either by native peoples or by more recent comers. A coordinated, multi-phase attack should be made on the problems of population and cultural movements along the Arctic littoral between Siberia and Greenland-Labrador during past millenia. The physical anthropology of the native peoples of the American Arctic is very

nearly an untouched field. The few good studies which have been made have merely scratched the surface. And in applied anthropology, untold opportunities remain. In all instances the deficiencies can be corrected only through a large increase in personnel and multiplication of the meager funds presently available.

Part IV
RECOMMENDATIONS

THE ANALYSIS OF THE QUESTIONAIRES by the Committee has resulted in the undeniable conclusion that participation in polar research by the colleges and universities must be greatly expanded in all its aspects if scientific, economic, and military progress are to be adequate. Advances in polar development are dependent upon the fundamental research performed by scientists, but the nation's academic scientists are not participating in polar research to the extent necessary. One consequence is that too few students are being trained for careers in this research.

FUNDING OF POLAR WORK

The Committee finds that this unsatisfactory condition of participation by academic scientists and institutions can be ascribed in large part to the lack of suitable financing; therefore, our first recommendation is:

> RECOMMENDATION 1—*Financial support for investigations of polar problems at colleges and universities must be greatly increased, with emphasis on the basic research needed to solve the problems. Further, the support must provide for long-term continuity.*

Except for a few small projects supported by the NSF, most Arctic research is financed by other government agencies, chiefly the military. Little money is therefore available for basic research, as contrasted with developmental work. The Office of Naval Research, which supports the Arctic Research Laboratory, and the Geophysical Research Directorate of the Air Force, must be singled out as two government agencies financing basic Arctic research.

For Antarctic research, Congress appropriates directly to the U. S. Antarctic Research Program money which is disbursed by NSF.

However, the Committee feels that although Congress has followed a policy of increasing USARP funds for each fiscal year since the end of the IGY, Congress must recognize that even greater financial support will be necessary for several years to come if the U. S. is to maintain its research activities in the Antarctic, and to expand them as new scientific leads are developed by current, as well as new, investigators. For the Arctic, funds are practically non-existent for some fields of research and wholly inadequate for others, a situation which the Committee views with concern.

Each research program, regardless of the field of investigation, requires that financial support continue year after year. Sufficiency and continuity of funds are necessary to build and maintain a team that will achieve worthwhile results. The quality of the personnel that can be obtained for any project improves as the time interval of firm financial support increases. Further, as time goes on it becomes increasingly difficult to employ trained people at any level when it is known that it is necessary to seek funds on a year-to-year basis.

Field work in polar regions is difficult, slow, and expensive. Best results require the efficiency of small teams of highly trained people. Such people may easily obtain positions in nonpolar work, positions which have a high degree of stability; jobs which have a support guarantee of one year or less are seldom attractive. We must make polar work, at both professional and sub-professional levels, as attractive as possible; one device is to be able to ensure that sufficient funds will have long-term continuity. The Committee fully realizes that the present general governmental policy does not permit guaranteed financial support of research projects for years in advance. We urge, however, that financial support be given for more than one year whenever appropriate. We feel that funds should be committed for at least five years and preferably for ten years before a long-term project is started.

MANPOWER

In examining manpower resources, the Committee finds that many scientists have abandoned polar research after a few years and some even after many years of participation. It is to be expected

that a certain proportion of scientists will change the central area of their interest after a time, but this Committee believes that such attrition from the ranks of polar scientists could be materially reduced by assurance of continued support. On the other hand, we believe that many of a large number of qualified and interested scientists who are not now participating would do so if given the proper opportunities for long-term work. Likewise, short-term participation should also be encouraged, especially in view of its obvious role in cross-disciplinary research. Lastly, the survey also strongly indicated that in most fields there has been no increase in the number of graduate students entering polar research in recent years, and in some fields there has been a distinct decrease. The significance of this deficiency in replacements for polar research manpower cannot be overemphasized. Vigorous long-term programs of polar research guided by college and university scientists provide one of the best means of attracting young scientists to this work.

RECOMMENDATION 2—*Every effort must be made to increase scientific manpower in polar research. Professional scientists now working on polar problems should be encouraged to continue their research; other qualified scientists should be invited to consider participation in polar research through publicizing the importance of research challenges of the polar regions; and active recruitment should be initiated to increase the number of capable students embarking on careers in polar research.*

LOGISTICS

The polar regions are two huge areas about which we know relatively little because of few and scattered observations. The polar environment is not favorable for permanent occupancy and many field investigations can be conducted only during the short summers. It is difficult to transport men and equipment into and within these areas, but for scientific programs such transportation must be both regular and readily available. In addition, communication must be rapid and dependable. Special needs for food, shelter, and clothing in these inhospitable regions must be met by careful planning.

Most polar expeditions in the past have had to depend upon military organizations for logistic support because these organiza-

tions alone had the necessary equipment for transportation and living in the cold environment. In past polar exploration, the military has often viewed the logistic support of scientific work in a category well below first priority. In many instances opportunities for the accomplishment of some scientific field investigations were afforded *only* by attaching the scientific party to military operations aimed at other objectives. Now that the reconnaissance type of exploration has been largely accomplished, the real additions to our knowledge in polar areas will depend upon well-conceived and adequately supported scientific field programs with logistics keyed to the scientific needs.

The logistics must be controlled by those directing the scientific field work. Wherever practical, contracts with commercial transportation or research firms, or reliance upon the resources of a university or research institution, should be permitted and supported. It seems likely that some circumstances will continue to require the unique capabilities of certain military or other governmental units for logistic support. Moreover, at least a few scientists will probably continue to find opportunities for certain field investigations afforded only by appending their projects to other, sometimes nonscientific, missions. In those cases, such as the ONR Arctic Research Laboratory, where the military has assigned top priority to logistic support of scientific work, the necessary field work proceeds on a much more stable basis.

When an expedition is planned for the purpose of scientific investigations, the entire effort should be applied to the accomplishment of scientific objectives. Logistic support should be flexible enough so it can be adapted to changing scientific requirements resulting from field discoveries. The scientists bear responsibility for planning the field program in relation to the logistic support available, but in many cases scientists would be better able to do this if they could and would avail themselves of advice from organizations and individuals with the proper kind of polar experience. (See Recommendation 6.)

The Committee also believes that a wider variety of types of transportation, such as ice-breakers, submarines, helicopters, light

planes, and possibly hovercraft should be made available to scientific expeditions in polar regions.

Results of the survey bring the Committee to its third recommendation:

> RECOMMENDATION 3—*Substantial and reliable logistic support for polar field investigations must be regularly available and must be directed specifically toward scientific objectives.*

POLAR CENTERS

The Committee is aware that most polar research is of an interdisciplinary nature and that many colleges and universities encourage cooperative effort. With Arctic, Antarctic, or polar regions as a common theme, scholars are stimulated by the cross-fertilization from seminars, colloquia, etc. However, with the present diffuse organization of academic polar research, graduate students who are preparing for scientific careers do not know where they can pursue specific kinds of polar research in the proper milieu and where they can find employment related to their specialties. This brings the Committee to its fourth recommendation:

> RECOMMENDATION 4—*More polar "centers" or "institutes" should be established within the institutional frameworks of colleges and universities. Conversely, we strongly recommend that no single or "monolithic" center or institute be established by either the Federal Government or by a group of academic institutions.*

Various academic institutions have already created formal organizations for polar research, and several more are considering such developments.[1] The Committee strongly supports the creation of these specialized polar research groups. Such polar groups should be sponsored, and partially supported, by the home institution. It is imperative, however, that NSF and other agencies, governmental or private, assist these groups through appropriate financial aid.

[1] Polar "centers" exist at the University of Alaska, the Ohio State University, and the University of Wisconsin. Plans are progressing for formal establishment of a "center" at the University of Washington. Some consideration has been given to the idea of a polar research center at The University of Michigan, but no formal plan has been developed.

Each polar "center" will naturally have a somewhat different character, and each will undoubtedly develop its own specialties. This is a healthy condition for the whole realm of polar research.

The Committee examined the possible roles of a central or national polar institute as a part of the Federal Government, or as a creation of a group of universities, but reached the conclusion that this approach would limit the development of polar research in a country as large as the United States.

NSF SUPPORT FOR ARCTIC RESEARCH

In reviewing the sources of funds for conducting all phases of polar research, the Committee gave consideration to the fact that, at present, applications for grants in support of Arctic research must compete with other proposals submitted to NSF, and because of the greater cost of Arctic work, such research is inadequately supported. This inadequacy is critical because scientific problems in *polar* research cannot be solved if *Arctic* research is lacking. More generous financial support must therefore be forthcoming if a balanced program of polar studies is to be achieved. If financing problems can be solved, work will go forward rapidly in now neglected fields such as anthropology, auroral studies in the polar cap, basic taxonomic studies, seismic soundings at spot locations, heat balance of the Arctic Ocean, paleontology and paleobotany, and paleomagnetism.

Such financing should provide for full scientific freedom of action, and thus must be independent of Arctic programs sponsored by the Department of Defense. We do not feel that a budget for Arctic research should be established parallel to that of USARP. Indeed we are convinced that USARP should, at an appropriate future date, be re-established on a subject matter basis.

We therefore present:

RECOMMENDATION 5—*That each scientific field within the NSF develop a program of financing specifically for Arctic research and that each review panel include university investigators active in Arctic work.*

ASSOCIATION OF UNIVERSITIES

The pre-eminent position of academic scientists in polar research and the importance of cooperation between academic institutions for the most effective pursuit of research in polar problems leads us to our final recommendation.

RECOMMENDATION 6—*Full utilization should be made of the experience and competencies of academic polar scientists by governmental and other agencies interested in polar problems through an Association of Universities for Polar Research.*

The anticipated development of increased numbers of polar research centers in colleges and universities, and the realization of the importance of inter-university and inter-disciplinary coordination and exchange of information, has led to the formation by interested university scientists of a committee for the establishment of an Association of Universities for Polar Research. The functions of this association will be to promote cooperation between universities in the field of polar research and to provide an agency for the effective representation of academic polar scientists in matters pertaining to the national effort in the field.

The Committee feels that the Association of Universities for Polar Research will be a useful adjunct to existing agencies concerned with polar endeavor and will play a vital role in advancing this research in the United States.

Appendix 1

Polar Research Questionnaire

INFORMATION ON POLAR
INTERESTS IN THE FIELD OF _____

NAME OF INSTITUTION _____

DEPARTMENT _____

NAME OF PERSON COMPLETING
THIS QUESTIONNAIRE _____

OFFICIAL POSITION _____

ADDRESS _____

_____

A. MANPOWER

1. Number of experienced professional-level* members of your department who are now, or have been in the past, engaged in polar research ..... _____
2. Number of qualified professional-level members of your department who could participate in polar research activities if given the opportunity ..... _____
3. Number of graduate students now working toward a higher degree who have had, or are now engaged in, some form of polar research ..... _____
4. Number of graduate students currently working on a higher degree in your department ..... _____
   (This question is asked in order to get some indication of the size of your department.)

* Professional-level refers to all teaching or non-teaching academic personnel with academic or research appointments of a permanent type.

B. RESEARCH FACILITIES

1. The UCPR is interested in knowing what *special* facilities your department has for carrying out research problems related to polar areas. Standard equipment such as microscopes, balances, etc., should not be listed. A special facility would be such items as a *cold-room laboratory,* or special equipment for measuring low temperatures, etc.

   Please list these special facilities available to your department.

   _____

   _____

   _____

2. Do your library facilities include:
   a. A separate polar library .....
   b. A departmental library which attempts to keep most classical and present polar books .....
   c. The usual publications relating to polar research and exploration incorporated in the general library .....
   d. Very limited polar library facilities .....

3. Does your department or institution maintain any collections of materials related to polar areas such as faunal collections, mineral specimens, artifacts, etc. .....
   If so, what are they?

C. CURRICULUM

1. What courses are offered in your department in which polar problems constitute all or a *major portion* of the course content?

Descriptive Name of Course	Average Enrollment		By whom Taught	Frequency Given (once a year, every other year, etc.)
	No. of grad. students	No. of undergrad. students		

2. Are any courses of the type named above contemplated for the future?
   Name of Course *Graduate or Undergraduate?*

3. How many theses related to polar areas have been produced by graduate students on the Master's and Ph.D. levels in the past 5 years?
   Master's _____ Ph.D. _____

4. How many graduate students are currently working on Masters' or Ph.D. dissertations related to polar areas?
   Master's _____ Ph.D. _____

5. Many graduate students now enrolled have had some sort of previous polar experience. It is the intent of the UCPR to find out how and where such experience is gained. Please check.
   a. IGY experience _____
   b. Government-sponsored expeditions _____
   c. Privately sponsored expeditions _____
   d. Other (please describe)

D. POLAR RESEARCH ACTIVITIES

1. What research projects related to polar areas are now being carried out by members of your department? For each project give the following:
   a. Name of Project .....
   b. Source of funds .....
   c. Amount (optional) .....
   d. Length of time .....
   e. Who furnishes logistic support? _____

2. Give the same information for projects completed in the past 5 years.

3. Give same information for projects proposed within the next two years. In addition, please state whether *logistic support* was satisfactory or not. If *not satisfactory,* brief comments are invited.

4. List and briefly comment on any deficiencies within your field of polar research (e.g., research problems that need immediate attention; facilities for doing the work; funds; personnel; logistics).

Appendix 2

COMMENTS ON SUMMARY REPORT OF THE DARTMOUTH CONFERENCE AFTER THE UNIVERSITY COMMITTEE ON POLAR RESEARCH had compiled the results of the questionnaire survey and had reviewed them, the general recommendations were developed from interpretations of needs indicated by the survey. During these discussions there were frequent references to the Dartmouth Conference of December 18–19, 1958, and the "Summary Report" distributed after that conference. As many of the same questions were being considered by the Committee, it was decided that the Committee could effectively state some of its conclusions by commenting upon the Dartmouth Report's ten points outlining the functions of an association of polar centers (p. 4 of that report). In the Dartmouth Report the stated points are in relation to an association of research centers with a central administration; thus many are incompatible with our Committee's stand against the concept of a unified administration.

The Dartmouth Conference Summary Report statements are quoted below in italics, followed in each instance by the comment of our Committee.

"(1) *To keep itself informed of polar research as a whole and to act as a clearing house nationally and internationally for scientific information concerning the polar regions.*"

COMMENT: This is an obvious and important function of the Association of Universities for Polar Research and will be more or less automatic because the AUPR committee members are actively engaged in polar work, and are well informed in matters of polar research related to their own field. The Arctic Institute of North America is already contributing to this function and is in an excellent position to aid the universities.

"(2) *To house a specialized polar library and documentation center, together with a repository of valuable records of expeditions and other activities.*"

COMMENT: Although questionnaires report very few separate polar libraries, there are now good working libraries in many institutions distributed throughout the country. The Committee believes this distribution is proper as investigators in need of these facilities will have direct access to them. Improvements could be made in the availability of copies or rare library items, translations, research records, and similar material for individual investigators.

"(3) *To maintain a scientific museum also useful for popular instruction.*"

COMMENT: This is not considered a function of the AUPR. It would be impractical to start a new polar museum with all types of collections (e.g., geological, archaeological, biological) when good museums already exist at various institutions. The Committee highly recommends that existing museums be strengthened with additional acquisitions and more curatorial assistance for collections of concern to polar research.

"(4) *To provide a temporary home for field scientists engaged in report writing, or for those in need of instruction before joining expeditions.*"

COMMENT: At present the individual universities concerned are performing this function, and it seems logical that they should continue to do so. The AUPR could assist in improving opportunities for visiting research personnel at institutions with special facilities. The universities can provide the only logical homes for graduate students returning from the field and wishing to take further course work, write theses, or carry on laboratory work.

"(5) *To publish scientific reports not readily issued elsewhere.*"

COMMENT: Again, this Committee does not consider this to be a function of the AUPR. Publication of lengthy, data-filled

papers is already possible in many outlets, for example, in the Technical Series of the Arctic Institute of North America. The World Data Center A, with its eleven branches, already functions in such a manner, and individual institutions usually have adequate facilities for publication of reports.

"(6) *To provide housing and repairs for specialized polar equipment, and, if need be, to provide designs for new types.*"

COMMENT: This should be a function of the individual centers. Needs differ so greatly in the various fields that it would be unrealistic to centralize such responsibilities. On the other hand, such facilities are needed and should be developed at strategic locations. For example, an instrument repair shop at McMurdo Sound would be extremely valuable for keeping seismic and other field instruments in good working condition.

"(7) *To serve as a reservoir of logistic 'know-how'.*"

COMMENT: University scientists should use means at their command to promulgate tried and proven logistic techniques. There is a rapidly growing body of civilian scientists who, through their combined Arctic and Antarctic experiences, are capable of solving many logistic problems, some of which are now exclusively in the hands of the military. Although it is doubtful whether the logistic support of the military can be dispensed with in the near future, there are probably many expeditions in which the Army, Navy, or Air Force supporting units could be relieved of a considerable share of obligation to the scientific programs, and be replaced by contract operation.

"(8) *To provide a specialized scientific staff that could plan and carry on research and be a source of scientific information.*"

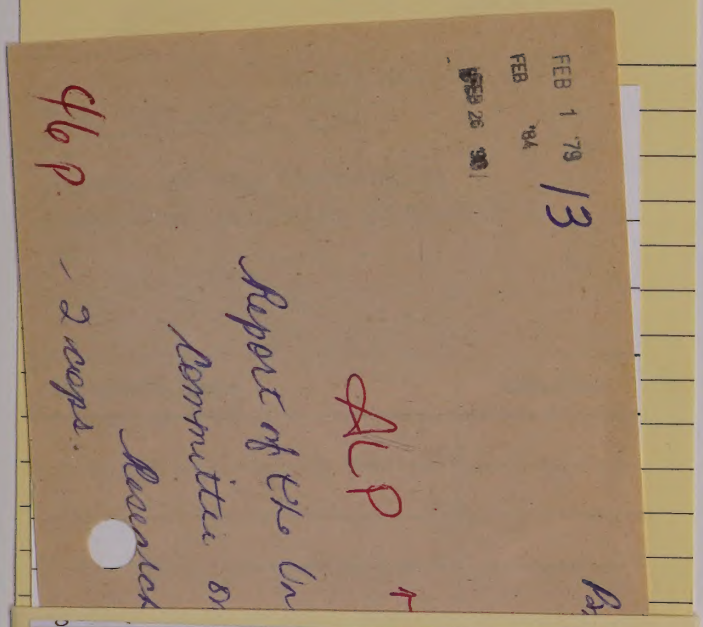
COMMENT: There already exists a shortage of experienced personnel in some fields and the establishment of another organization that would compete with existing university and governmental programs for manpower would only aggravate the situation. Training is not directly or effectively fostered at nonacademic institutions.

"(9) *To raise, apportion, and administer research funds.*"

COMMENT: These are considered by the Committee to be proper functions between universities and granting agencies.

"(10) *To provide a permanent focus that would encourage those already engaged in polar research and inspire those wishing to enter it.*"

COMMENT: We heartily approve of this function, and are confident that it would be performed by an AUPR.



Pam: 001.891: (*2)

Report of the University
Committee on Polar Research

Boreal Institute for Northern
Studies Library
CW 401 Bio Sci Bldg
The University of Alberta
Edmonton, AB Canada T6G 2E9

University of Alberta Library
0 1620 0327 7520

Geophysics of the Solid Earth—Maurice Ewing, Columbia University

Physics of the Upper Atmosphere—C. T. Elvey, University of Alaska

Meteorology and Climatology—P. E. Church, University of Washington

Oceanography—C. A. Barnes, University of Washington

Geology—J. C. Craddock, The University of Minnesota

Glaciology—R. P. Goldthwait, The Ohio State University

Soil Science—M. G. Morgan, Dartmouth College

Biological Sciences—W. S. Benninghoff, The University of Michigan

Health Sciences—I. M. Taylor, University of North Carolina

Anthropology-Archaeology—V. F. Ray, University of Washington